

# NATURAL RESOURCES CONSERVATION SERVICE

## CONSERVATION PRACTICE STANDARD

### Nutrient Management

(Acre)

Code 590

#### DEFINITION

Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

#### PURPOSES

- To budget and supply nutrients for plant production.
- To properly utilize commercial fertilizers, animal manures and other materials as plant nutrient resources and soil amendments.
- To minimize agricultural pollution of surface and ground water resources.
- To maintain or improve the physical, chemical and biological condition of soil.

#### CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

#### CRITERIA

##### General Criteria Applicable to All Purposes

Plans for nutrient management shall comply with all applicable Federal, state, and local laws and regulations.

All criteria and components for plans shall be based, at the minimum, on a field by field basis.

Realistic yield goals shall be established based on historical yield data or soil productivity information. An additional 10% can be added to

the average and/or historical yields to account for management and technology. For new crops,

Purdue University (PU) or appropriate industry yield recommendations shall be used until documented yield information is available.

A nutrient budget for nitrogen (N), phosphorus (P), and potassium (K), as a minimum, shall be developed as part of a plan that considers all potential sources of nutrients including, but not limited to:

- Plant available soil nutrients
- legume credits (**Table 1**)
- commercial fertilizer
- animal manures
- waste water
- irrigation water
- other nutrient containing materials
- Land receiving nutrients shall be evaluated for environmentally sensitive areas including, but not limited to:
  - perennial water bodies
  - areas of concentrated flow
  - surface inlets
  - Karst terrain
  - wellhead protection areas
  - those areas prone to flooding, leaching, and runoff

Hydrologically sensitive areas may change seasonally. These environmentally sensitive areas shall be evaluated and documented for minimum application setback distances. For manure application setbacks refer to the FOTG standard WASTE UTILIZATION (633).

**Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.**

### Soil Sampling and Laboratory Analysis (Testing)

Nutrient planning shall be based on current soil tests, (not older than four (4) years) using sampling methods developed in accordance with PU guidance. Soil testing shall include analysis for any nutrient or soil property for which specific information is needed to develop the nutrient management plan. See PU publication AY-281.

Soil samples shall be analyzed by laboratories that have been state certified by:

- State Certification Program, or
- The North American Proficiency Testing Program (Soil Science Society of America) with results forwarded to the State Certification Program for evaluation.

### Nutrient Application Rates

Soil amendments shall be applied to adjust soil pH to the appropriate range for the cropping system based on **Table 2 – Soil pH Recommendations for Various Crops on Various Soils** or PU AY-9-32 Tri-State Fertilizer Bulletin and related bulletins for other crops.

Nutrient values of animal manures, biosolids and other nutrient-containing materials shall be determined prior to land application based on laboratory analysis, acceptable “book values” listed in the Agricultural Waste Management Field Handbook (AWMFH) Chapters 4 & 11, or historic records for the operation. Refer to the FOTG standard WASTE UTILIZATION (633).

The application rate (in/hr) of liquid materials shall not exceed the soil infiltration rate, and shall be adjusted to minimize ponding and avoid runoff. The total application shall not exceed the field capacity of the soil and shall be adjusted to minimize loss to subsurface tile.

Recommended nutrient application rates shall consider realistic yield goals, current soil test results, and management capabilities. The planned rates of nitrogen and phosphorus application shall be determined based on the following guidance:

**Chart A** – “Offsite Risk Pre-Screening Table” shall be used on all fields or management zones to determine if a more detailed risk assessment is needed. The total is determined by adding the

values (0, 2, and 4) from all 5 screening factors together. Soil Erosion – Water (RKLS) can be found in the Field Office Technical Guide (FOTG). Surface Runoff Class and the Nitrate Leaching Index (LI) can be found in the FOTG Section II - Water Quantity and Quality Interpretations.

**Chart A. Offsite Risk Pre-Screening Table**

Screening Factors	Low (0)	Medium (2)	High (4)*
Soil Erosion – Water (RKLS)	Low < 20	Medium 20 - 37	High > 37
Surface Runoff Class	N/VL	L/M	H/VH
N Leaching Index (LI)	0-2	3-9	10+
Distance to Waterbody (ft)	100+	31-99	<30
Soil Test Bray P1/M3 (ppm)	≤ 50	51-100	> 100
If the total is > 6, or Bray P1/Mehlich 3 is > 200 ppm, the Offsite Risk Index (ORI) must be completed.			

\* For screening factors in this rating category, potential management options to address the issue(s) shall be discussed with the producer during the development of the management plan.

If the total of the Offsite Risk Pre-Screening Table is > 6, or soil test Bray P1/Mehlich 3 is > 200 ppm, the “**Offsite Risk Index (ORI)**” shall be completed.

**If the total of the Offsite Risk Pre-Screening Table (Chart A) is ≤ 6, use the following guidance:**

#### Nitrogen Applications

- Commercial fertilizer application rates shall be based on PU guidance and shall match recommended rates within ± 10%. See PU AY-9-32 Tri- State Fertilizer Bulletin and related bulletins for other crops.
- Animal manure, biosolids, and other N-containing material application rates shall be based on the potentially available nitrogen (PAN) content of material as it leaves the storage. PAN means the nitrogen that could be realistically taken up by the crop during one (1) growing season. PAN is usually calculated as the sum total of: ammonium nitrogen; nitrate nitrogen (if applicable); and

the percent organic nitrogen that will mineralize in one (1) growing season.

- Application rates for non-legumes shall be based on PU guidance. See PU AY-9-32 Tri-State Fertilizer Bulletin and related bulletins for other crops
- Application rates for legume crops are as follows:

**Soybean** – Up to 150 lbs N/Ac/yr

**Legume Hay** – Up to 75 lbs N/Ac/harvest of hay, not-to-exceed 300 lbs N/Ac/yr.

#### Phosphorus Applications

- Commercial fertilizer application rates shall be based on PU guidance and shall match the crop rotation recommended rates within  $\pm 10\%$ . See PU AY-9-32 Tri-State Fertilizer Bulletin and related bulletins for other crops.
- Animal manure, biosolids, and other P-containing material application rates shall be based on **Chart B**. “Organic Nutrient Application Guidelines Based on Soil Test Phosphorus”.

#### **Chart B. Organic Nutrient Application Guidelines Based on Soil Test Phosphorus**

Soil Test Phosphorus Level (Bray P1/Mehlich 3 ppm)	Basis for Nutrient Application
$\leq 50$ ppm	Nitrogen Based
51 – 100 ppm	NTE 1.5 x Crop $P_2O_5$ Removal <sup>1</sup>
101 – 200 ppm	NTE Crop $P_2O_5$ Removal <sup>1</sup>
> 200 ppm	No P Application

<sup>1</sup> Found in Table 3

NTE = Not To Exceed

**Chart B Explanation.** The nutrient application guidelines in Chart B are meant to address longer-term P loading to the soil. For example, if soil test phosphorus levels are  $\leq 50$  ppm (Bray P1/Mehlich 3), then the P applications are based on the current year’s crop nitrogen needs. If the soil test is 51 – 100 ppm and a corn (160 bu./acre) – soybean (40 bu./acre) rotation removes an average of 50 lbs  $P_2O_5$ /acre/yr (60 lbs  $P_2O_5$ /acre/yr for corn and 40 lbs  $P_2O_5$ /acre/yr

for soybean), then the long-term  $P_2O_5$  application rate shall not exceed 75 lbs/acre/yr ( $50 \times 1.5 = 75$ ). If the soil test is 101-200 ppm, and the previous example crop rotation is used, then the long-term  $P_2O_5$  application rate shall not exceed 50 lbs/acre/yr. Using Chart B, there shall be no application of phosphorus if the Bray P1/Mehlich 3 soil test is > 200 ppm.

A single application of organic nutrients may be made at a rate equal to, but not to exceed, the crop N needs for that crop year, as long as the soil test phosphorus is  $\leq 200$  ppm. The longer-term P based application rates can then be managed by selecting an appropriate frequency of application.

The **Offsite Risk Index (ORI)** shall be conducted to assess the potential for nutrient movement from a field under any of the following conditions:

- The total from Chart A is > 6, or
- The Bray P1/Mehlich 3 soil test is > 200 ppm, or
- The field has an identified or designated nutrient related water quality impairment, or
- The producer deems the nutrient application rate from “Chart B” as too restrictive.

The ORI can be found in the FOTG Section II - Water Quantity and Quality Interpretations. In such cases, plans shall include:

1. A record of the assessment for each field or sub-field, and
2. Information about conservation practices and agronomic management activities used to reduce the potential of offsite nutrient and sediment movement.

After completing the ORI assessment, the results of the assessment and recommendations shall be discussed with the producer during the development of the management plan.

The planned rates of other nutrient applications shall be determined based on the following guidance:

**Potassium (K) Application** – K application rates should be based on soil test results matching the crop rotation recommended rates. Excess K shall not be applied in situations causing unacceptable nutrient imbalances in

crops or forages. When forage quality is an issue associated with excess K application, follow PU guidance.

- **Other Plant Nutrients** - The planned rates of application and management of other nutrients shall be consistent with PU guidance (and/or industry practice when recognized by PU).
- **Starter Fertilizers** – Starter fertilizer applications shall be included in the nutrient budget.

### **Nutrient Application Timing**

Timing and method of nutrient application shall correspond with sound agronomic principles while considering cropping system limitations, manure storage, if applicable, weather and climatic conditions, and field accessibility.

### **Nutrient Application Methods**

Nutrients shall not be applied to frozen, snow-covered, or saturated soil when the risk for runoff exists from edge of field or via surface tile inlets.

Nutrient applications associated with irrigation systems shall meet the requirements of FOTG standard Irrigation Water Management (449).

### **Additional Criteria to Improve the Physical, Chemical, and Biological Condition of Soil.**

Soil amendments shall be applied to maintain or improve the soil's structure, chemical properties, or biological condition.

When bio-solids are applied, potential pollutants (including arsenic, cadmium, copper, lead, mercury, nickel, selenium, zinc and others as required) shall be conducted in accordance with the waste generators land application permit and all applicable Federal, state and local laws or regulations.

### **CONSIDERATIONS**

Consider application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere. Suggestions include:

- Refer to **Table 4**,

- split applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- avoid fall and winter nitrogen application for spring seeded crops or delay application of fall-applied N until the soil temperature is below 50° F and use a nitrification inhibitor, if applicable,
- apply nutrient containing materials uniformly to application areas or as prescribed by precision agricultural techniques, and/or
- inject or immediately incorporate animal manure and other organic by-products,
- delay field application of nutrients if precipitation capable of producing runoff and erosion is forecast.
- minimize N volatilization losses by injecting or immediately incorporating manure and other volatile N sources into the soil after application.

Consider using cover crops to utilize and recycle residual nitrogen.

Consider other soil sampling techniques, where appropriate. (For example: Pre-Sidedress Nitrate Test (PSNT) on manured or high organic matter soils, deep soil testing for phosphorus, and soil surface sampling for phosphorus accumulation or pH changes in no-till.)

Consider collecting plant tissue samples and accompanying soil samples to properly identify observed nutrient deficiencies. When used, sample collection techniques should be done in accordance with PU recommendations.

Consider not applying waste to soils when the potential for soil compaction and creation of ruts is high.

Consider minimizing odors associated with the land application of animal manures, especially when applied near or upwind of residences

Consider modifying animal diets to reduce manure nutrient content and to enhance the producer's ability to manage manure effectively.

### **PLANS AND SPECIFICATIONS**

Plans and specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s): using nutrients to achieve production

goals and to prevent or minimize water quality impairment.

The following components shall be included in the nutrient management plan:

1. aerial photograph or map and a soil map of the site,
2. current and/or planned plant production sequence or crop rotation,
3. realistic yield goals for the crops in the rotation,
4. results of soil, plant, water, manure or other material sample analyses,
5. quantification of all nutrient sources,
6. complete nutrient budget for nitrogen, phosphorus, and potassium for the rotation or crop sequence,
7. recommended nutrient rates, timing, form, and method of application,
8. location of designated sensitive areas or resources and the associated, nutrient management restriction,
9. guidance for implementation, operation, maintenance, and recordkeeping.
10. discussion about how the plan is intended to prevent the nutrients (N and P) supplied for production purposes from contributing to water quality impairment.

When applicable, plans shall include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

#### **OPERATION AND MAINTENANCE**

The owner/operator is responsible for the operation and maintenance (O&M) of this practice. O&M addresses the following:

- periodic review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each soil test cycle.
- protect fertilizer and other organic by-product storage facilities from weather and accidental leakage or spillage. This should be addressed in a spill response plan.
- calibration of application equipment to provide for even application of fertilizer and manure at intended rates.

Recordkeeping, as applicable and based on PU ID-198, includes:

- Documentation of the source, analyses and actual rate at which all nutrients were applied. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reasons for the differences.
- soil test results and recommendations for nutrient application,
- dates and method of nutrient applications,
- crops planted, planting and harvest dates, yields, and crop residues removed,
- results of water, plant, and organic by-product analyses, and
- dates of review and person performing the review, and recommendations that resulted from the review.
- Records shall be maintained for five years; or longer if required by other Federal, state, or local ordinances, or program or contract requirements.
- Workers shall be protected from and avoid unnecessary contact with commercial fertilizers, manure and other materials. Protection shall include protective clothing and eyewear. Extra caution must be taken when handling ammonia sources of nutrients, or when dealing with manure and other organic materials stored in unventilated enclosures.
- Material generated by the cleaning of nutrient application equipment shall be disposed of properly. Excess material shall be collected and stored or field applied, as a nutrient source, in an appropriate manner. Excess material shall not be applied on areas with a high risk for runoff and, or leaching.
- The disposal or recycling of nutrient containers shall be done according to state and local guidelines or regulations.

**Table 1. Nitrogen Credits from Soil Organic Matter and Previous Crops <sup>1)</sup>**

Source	Nitrogen Credit (lbs/ac)
<b>From Soil Organic Matter (O.M.):</b>	
0-8% O.M. Mineral Soils	0
> 20% O.M. Organic Soils <sup>2)</sup>	40
<b>From Previous Crops:</b>	
Corn & Most Crops	0
Soybean prior to corn only	30
Grass Sod & Pastures	40
Established Forages Legumes <sup>3)</sup> 40 + 20 X (plants/sq. ft.) [Max 140 lbs/ac]	40-140 <sup>5)</sup>
Annual Legume Cover Crop <sup>4)</sup>	30 <sup>5)</sup>

Footnotes:

1. Tri-State Fertilizer Recommendations Extension Bulletin E-2567, July 1995.
2. For organic soils with greater than 20 percent organic matter, adjust rates using a pre-sidedress N soil test or reduce N rates by 40 lb/acre.
3. Established more than one year.
4. N credit is variable. When a heavy growth follows small grain harvest the N credit can be considerably higher.
5. Actual N availability will depend on how the forage is managed. If the forage is incorporated (even shallow) the N availability is generally (weather dependent) much higher. If forage residue is left on top (No till) breakdown of the organic N and movement into the soil is very moisture dependent. A dry year will capture less of the potential nitrogen.

**Table 2 - Soil pH Recommendations for Various Crops on Various Soils <sup>1</sup>**

Crop	Mineral Soil Subsoil pH > 6	Mineral Soil Subsoil pH < 6	Organic Soils (>20% O.M.)
Alfalfa	6.5	6.8	5.3
Other Forage Legumes	6.0	6.8 <sup>2)</sup>	5.3
Corn	6.0	6.5	5.3
Soybean	6.0	6.5	5.3
Small Grains	6.0	6.5	5.3
Other Crops	6.0	6.5	5.3

Footnotes:

1. Source - Tri-State Fertilizer Recommendations Extension Bulletin E-2567, July 1995.
2. Birdsfoot Trefoil should be limed to pH 6.0

**Table 3. Approximate Nutrients Removed by Crops (Lbs/Acre) <sup>3</sup>**

Crop	Unit	Nitrogen	P2O5	K2O
Alfalfa (hay) <sup>1)</sup>	Ton	56	13	50
Grasses - Cool Season (hay)	Ton	50	17	55
Corn (Grain)	Bushel	0.9	0.37	0.27
Corn (Stover)	Bushel	0.67	0.19	1.06
Corn Silage <sup>2)</sup>	Ton	9.0	3.3	8.0
Oats (Grain)	Bushel	0.65	0.25	0.20
Oats (Straw)	Bushel	0.35	0.15	1.0
Sorghum (Grain)	CWT	1.38	0.39	0.39
Sorghum (Stover)	CWT	1.05	0.66	3.03
Soybean <sup>1)</sup>	Bushel	3.8	0.8	1.4
Tobacco (leaf)	CWT	3.5	0.83	6.16
Tobacco (Stem and Suckers)	CWT	2.75	0.75	3.25
Wheat (Grain)	Bushel	1.27	0.63	0.37
Wheat (Straw)	Bushel	0.40	0.09	0.91

Footnotes:

1. Inoculated legumes fix nitrogen from the air.
2. 6 bushels of grain = 1 ton of silage
3. Source - Tri-State Fertilizer Guide, Ohio Agronomy Guide, National Plant Food Institute and others.

**Table 4. Forms of Nitrogen, Placement, and Timing of Application for Spring-Seeded Crops (Other than Starter).**

Nitrogen Form	Fall Applied <sup>7)</sup> Soil <50° F	Spring Applied Soil <50° F	Spring Applied Soil >50° F	Early Summer Sidedress or Split
Urea – Broadcast		X <sup>3)</sup>		
Urea – Incorporate <sup>2)</sup>		X <sup>4)</sup>	X <sup>4)</sup>	X <sup>5)</sup>
Urea with Urease Inhibitor			X <sup>4)</sup>	X
UAN – Broadcast		X <sup>3)</sup>		
UAN – Incorporate		X <sup>4)</sup>	X <sup>4)</sup>	X <sup>5)</sup>
Ammonium Based		X <sup>3) 4)</sup>	X <sup>4)</sup>	X <sup>5)</sup>
NH <sub>3</sub> Inject Only		X	X	X <sup>5)</sup>
NH <sub>3</sub> Inject Only with Inhibitor	X <sup>1)</sup>	X <sup>4)</sup>	X <sup>6)</sup>	

Footnotes:

1. Only recommended on well drained silt loam and loam soils with low to medium leaching potential.
2. Incorporation includes the use of standard primary and secondary tillage tools, knife, and injectors.
3. Preferred timing for wheat production.
4. Preferred timing for corn production on FINE OR MEDIUM textured soils that are tile drained to minimize nitrate leaching losses in tile flow.
5. Recommended for untilled poorly and somewhat poorly drained MEDIUM and FINE soils; and for COARSE TEXTURE soils.
6. On poorly and somewhat poorly drained soils.
7. Fall applications of N is not recommended on coarse-textured soils and south of U.S. 40.

## REFERENCES

- Listed below are references helpful in planning this practice:
- Offsite Risk Index (ORI) and Nitrate Leaching Index – NRCS (FOTG Section II – Water Quantity and Quality Interpretations)
- Agricultural Waste Management Field Handbook – Part 651, “National Engineering Handbook”, USDA-NRCS.
- Purdue University publications (some may be available on PU Extension website):
- AY-281, 1994, Soil Sampling for P, K and Lime Recommendations
- AY-9-32, 1996, Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa
- AY-277, 1993, Calculating Manure and Manure Nutrient Application Rates
- AY-278, 1993, Estimating Manure Spreader Capacity
- CES 227, 1990, updated 2001, How and Where to Get a Livestock Manure Analysis
- ID-101, 1994, Animal Manure as a Plant Nutrient Resource
- ID-198, Crop Production Recordkeeping System
- Manure Management Planner, Purdue University Computer Program
- Certified Soil Testing Labs – Farm Services Agency
- Confined Feeding Rules, Indiana Department of Environmental Management